

Neutron monitors – Study of solar and galactic cosmic rays

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1. Project description

The Physikalisches Institut at the University of Bern, Switzerland, operates two standardized neutron monitors (NM) at Jungfraujoch: an 18-IGY NM (since 1958) and a 3-NM64 NM (since 1986). NMs provide key information about the interactions of galactic cosmic radiation (GCR) with the plasma and the magnetic fields in the heliosphere and about the production of energetic CRs at or near the Sun (solar cosmic rays, SCR), as well as about geomagnetic, atmospheric, and environmental effects. The NMs at Jungfraujoch are part of a worldwide network of standardized CR detectors. By using the Earth's magnetic field as a giant spectrometer, this network determines the energy dependence of primary CR intensity variations near Earth in the energy range ~ 500 MeV to ~ 20 GeV. Thereby, NMs ideally complement space observations which mainly cover the energy range below the range of NMs.

Furthermore, the high altitude of Jungfraujoch provides a good response to solar protons ≥ 4.6 GeV and to solar neutrons with energies as low as ~ 250 MeV. NMs also play an important role in the space weather domain.

In 2021, operation of the two NMs at Jungfraujoch was pursued. The recordings of the NM measurements are published in near real-time in the NM database NMDB (<http://www.nmdb.eu>).

Due to renovation work in the Sphinx lab 2nd floor starting in May 2021, the electronics of the IGY NM had to be removed from the lab. In order to keep the interruption in the data collection of the IGY NM as short as possible, all electronics, i.e. high-voltage devices, counter electronics, barometer and data acquisition PC, were moved into the detector housing on May 8, 2021. This equipment was placed on the paraffin boxes (reflector of NM) at the front edge of the actual detector, which of course influenced the counting properties of the IGY NM. In addition, the barometer also had to be moved into the detector housing, i.e. the height above sea level of the barometer was thus about 1 meter higher. This corresponds to a reduction in the barometric pressure of about 0.1 mbar and thus result in an increase in the pressure-corrected NM count rate of less than 0.1%. Due to this small change, no correction was made to the barometer readings at the location of the barometer in the detector housing during the renovation work in the Sphinx lab. Finally, the electronics of the IGY NM could only

be moved back to the Sphinx lab on October 7, 2021 and the NM could be operated again in its original condition. Figure 1 shows the relative daily averaged counting rates of the NM stations Oulu, Jungfraujoch IGY, and Rome in 2021. The count rate of the IGY NM (red curve) starts to decrease a few days before May 8, 2021. On May 12, 2021 the count rate of the Jungfraujoch NM increased in two steps (not visible in Figure 1). The count rate decrease during the days before May 8, 2021 was also seen by the NM64 NM at Jungfraujoch, see Figure 2, and is probably caused by snow accumulations on and around the detector housings of the two NMs as this behaviour was not observed by other NM stations of the worldwide network. From Figure 2 it can be seen that the NM64 NM shows large seasonal variations. This behaviour can be explained by the impact that mainly during winter and spring there are large snow accumulations behind and on the detector housing of the NM64 NM. In June the snow starts to deliquesce, see large increase of the NM64 NM (green line) in Figure 2. In the months July to August or even until September there are no snow accumulations on the roof of the research station Jungfraujoch.

From these facts it is clear that the NM64 NM cannot be used to investigate the change in the count rate of the IGY NM during the phase of renovation work in the Sphinx lab although the two NMs are located very close to each other. The next nearby and reliable NM stations in the summer months of 2021 are the stations Oulu and Rome, see Figure 1. There are no clear changes visible in the count rate of the IGY NM in comparison to Oulu and Rome on May 8, 2021 and on October 7, 2021. If we consider count rate ratios in time intervals close to May 8, 2021 and October 7, 2021 and look at higher demand interval (hourly values), there is no hint that the IGY NM count rate showed a clear change after the respective changes in the configurations of the IGY NM, i.e. electronics in the detector housing vs. electronics in the Sphinx lab caused only a very small effect on the counting rate. Due to this situation we did not make corrections of the IGY NM count rate Jungfraujoch in the time interval from May 8 to October 7, 2021 as published in NMDB. The circumstance was added with a correspondent comment in the NMDB metadata table.

The dosimetric measurements with a GammaTracer device inside the detector housing of the NM64 neutron monitor were continued in 2021.

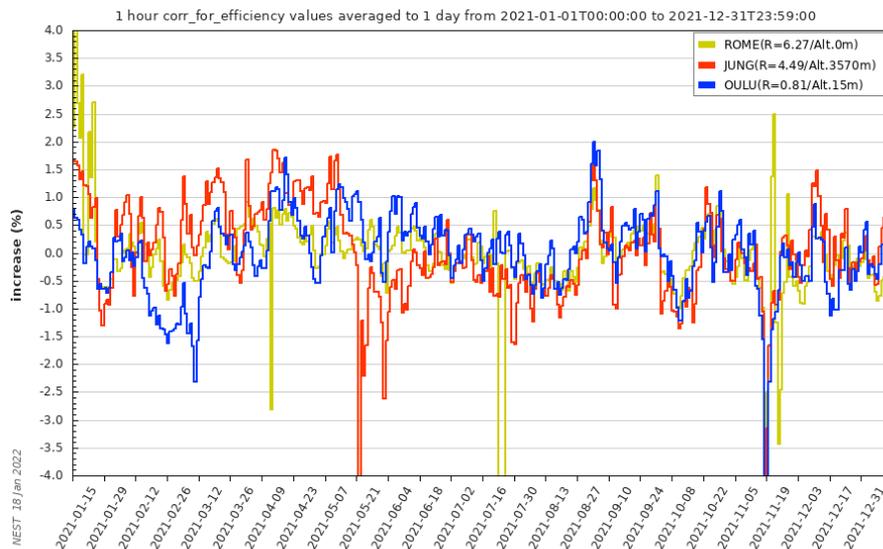


Figure 1. Relative daily averaged counting rates of the NM stations Oulu, Jungfraujoch IGY, and Rome for 2021. The electronics was moved into the detector housing on May 8, 2021 and was moved back to the Sphinx lab on October 7, 2021. Source: NEST under www.nmdb.eu.

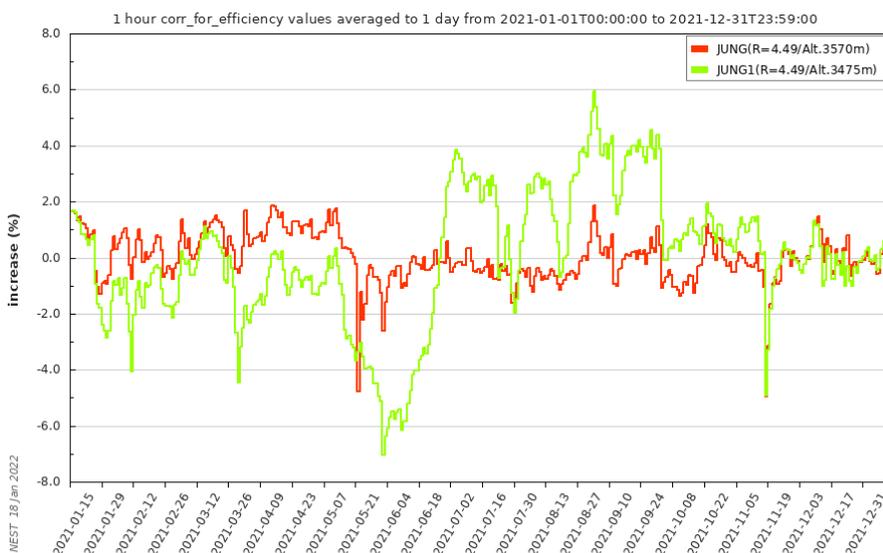


Figure 2. Relative daily averaged counting rates of the two NM stations at Jungfraujoch IGY and NM64 for 2021. The electronics was moved into the detector housing on May 8, 2021 and was moved back to the Sphinx lab on October 7, 2021. Source: NEST under www.nmdb.eu.

Internet data bases

<http://cosray.unibe.ch>
<http://www.nmdb.eu>

Collaborating partners / networks

European FP7 Project Real-Time Database for High Resolution Neutron Monitor Measurements (NMDB): <http://www.nmdb.eu>
 Robert Wimmer-Schweingruber, Bernd Heber, Christian Steigies, Stephan Böttcher, Extraterrestrial Physics Department of the Institute for Experimental and Applied Physics of the Christian-Albrechts University of Kiel, Germany
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